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Disclosure of the Invention

Under the aforementioned circumstances, an object of the present invention is to provide a method for recovering performance of a discharge gas processing apparatus, the method being capable of recovering NO_x removal performance of a deteriorated NO_x removal catalyst at low cost without replacing the deteriorated NO_x removal catalyst with a new catalyst and without adding a new catalyst.

Accordingly, a first mode of the present invention for attaining the aforementioned object provides a method for recovering performance of a discharge gas processing apparatus, which apparatus includes a honeycomb catalyst having gas conduits for feeding a gas to be treated, the catalyst being provided in a discharge gas conduit of the apparatus and, in use, performing gas treatment on the sidewalls of the gas conduits, characterized in that the honeycomb catalyst is in the form of a single layer of a flue gas NO_x removal catalyst, and that the method comprises rearranging the honeycomb catalyst for recovering performance thereof such that a deteriorated portion of the honeycomb catalyst is transferred from the inlet side of the

discharge gas conduit so that a predetermined range of the discharge gas conduit from the inlet side represents a portion other than the deteriorated portion, wherein the deteriorated portion is on the upstream side in terms of the flow of the gas to be treated, extends to cover the predetermined range of the honeycomb catalyst, and is determined on the basis of a sustained turbulent flow distance which is the distance from the inlet to a site where turbulent flow energy is lost in the course of transition from turbulent flow to laminar flow.

According to the first mode, the honeycomb catalyst is rearranged such that a deteriorated portion of the honeycomb catalyst is transferred from the inlet side of the discharge gas conduit so that a predetermined range of the discharge gas conduit from the inlet side represents a portion other than the deteriorated portion. Thus, the state of the portion effectively involved in NO_x removal can be renewed, whereby NO_x removal performance can be recovered.

A second mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to the first mode, wherein the honeycomb catalyst is rearranged such that the gas feed direction is inverted and the deteriorated portion is disposed on the downstream side in terms of the flow of the gas.

According to the second mode, the honeycomb catalyst is rearranged in the discharge gas processing apparatus such that the deteriorated portion is disposed on the downstream

side. Through inverting the honeycomb catalyst with respect to the gas flow direction, NO_x removal performance can be readily recovered.

A third mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to the first or second mode, wherein the honeycomb catalyst is cut perpendicular to the gas flow direction into a plurality of catalyst pieces, and the catalyst pieces are rearranged such that the deteriorated portion is not disposed on at least the furthest upstream side.

According to the third mode, the honeycomb catalyst is rearranged in discharge gas processing apparatus by cutting the honeycomb catalyst perpendicular to the gas flow direction into a plurality of catalyst pieces and rearranging the catalyst pieces such that a catalyst piece containing the deteriorated portion is not disposed on at least the furthest upstream side. Through changing the combination mode of the cut honeycomb catalyst pieces, NO_x removal performance can be reliably recovered.

A fourth mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to any of the first to third modes, wherein the honeycomb catalyst is rearranged after the deteriorated portion has been removed.

According to the fourth mode, the deteriorated portion is removed upon rearrangement of the honeycomb catalyst in the discharge gas processing apparatus. Thus, deteriorated

NO_x removal performance can be recovered readily and reliably.

A fifth mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to any of the first to third modes, wherein a portion of the sidewalls of the gas conduits of the honeycomb catalyst is removed through abrasion, the portion covering the deteriorated portion, and then the honeycomb catalyst is rearranged.

According to the fifth mode, upon rearrangement of the honeycomb catalyst in the discharge gas processing apparatus, the deteriorated portions on the sidewalls of the gas conduits are removed through abrasion. Through employment of the procedure, only predetermined portions are removed through abrasion, and removal rate can be reduced as compared with the case in which the entirety of the honeycomb catalyst is polished. Therefore, damage to the NO_x removal catalyst can be mitigated.

A sixth mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to any of claims 1 to 5, wherein the predetermined range corresponds to a range from the inlet to a site where the flow of the gas fed into the gas conduits is regulated and straightened, and the predetermined range Lb is determined on the basis of the equation: $Lb=a\cdot Lt$ (wherein Lt represents the sustained turbulent flow distance and a is a constant).

According to the sixth mode, performance of the

honeycomb catalyst can be recovered in a portion extending from the inlet thereof to a site where the flow of the gas fed into the gas conduits is regulated and straightened. Thus, NO_x removal performance of the portions of the sidewalls of the gas conduits where the gas to be treated is not effectively brought into contact can be reliably recovered.

A seventh mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to the first to sixth modes, wherein the range Lb (mm) is represented by equation (A):

$$Lb = a(Ly/Lys \cdot 22e^{0.035(Ly \cdot Uin)}) \quad (A)$$

(wherein Uins (m/s) represents a gas inflow rate, Ly (mm) represents an aperture size, Lys is an aperture size of 6 mm (constant value), and "a" is a constant falling within a range of 3 to 5, when the aperture size (Ly) is 6 mm and the gas inflow rate is 6 m/s).

According to the seventh mode, the deteriorated portion of the honeycomb catalyst can be reliably and precisely specified, whereby performance of the discharge gas treatment apparatus can be fully recovered.

A ninth mode of the present invention is drawn to a specific embodiment of the method for recovering performance of a discharge gas processing apparatus according to any of the first to seventh modes, wherein the honeycomb catalyst is immersed at ambient temperature in regeneration water containing substantially no chlorine and no cleaning

component, the catalyst is retransferred from the regeneration water, and residual water is retransferred from the catalyst.

According to the ninth mode, inhibitors deteriorating NO_x removal performance can be readily eluted and removed by merely immersing the NO_x removal catalyst at substantially ambient temperature in regeneration water. Thus, NO_x removal performance can be restored.

The present invention is applicable to any type of conventionally employed honeycomb catalyst. The term "honeycomb catalyst" refers to a catalyst unit including gas conduits having a cross-section of a polygon such as square, hexagonal, or triangular, and performing catalytic reaction on the sidewalls of the gas conduits. No particular limitation is imposed on the form of the honeycomb catalyst, and typical forms include a cylinder containing gas conduits each having a hexagonal cross-section, and a rectangular prism containing gas conduits each having a square cross-section and arranged in a lattice-like form.

In such a honeycomb catalyst, when a gas is fed into the honeycomb lattice, the following behavior is conceived. Specifically, the gas forms turbulent flow at the inlet thereof, whereby collision between reactive substance and sidewalls of the gas conduits (catalyst walls) is promoted. On the other hand, in the course of passage of the gas through the honeycomb lattice, the turbulent flow is gradually straightened and converted into laminar flow, whereby collision between reactive substance and sidewalls

of the gas conduits is suppressed. Eventually, the gas flow is in a general diffusion-controlled state.

In other words, the following mechanism is conceived. When a honeycomb NO_x removal catalyst has been continuously used for a long period of time, the catalyst surface is covered with a substance such as coal ash. In this state, NH_3 (ammonia) and NO_x, which are reactive substances, cannot approach the catalyst, and adsorption of ammonia, which determines the reaction rate, onto the catalyst is inhibited, resulting in deterioration of the catalyst performance. On the basis of the conceived mechanism, the surface of the used catalyst has been investigated along the longitudinal direction, and the inventors have found that a portion of the catalyst on the inlet side is thickly covered with the substance, the performance of the portion is considerably deteriorated, and that such covering is not observed in a portion of the catalyst on the outlet side, and the portion is virtually uninvolved in NO_x removal reaction. The present invention has been accomplished on the basis of these findings. Briefly, the inventors have found that deterioration of the catalyst is localized in a portion of the catalyst in the inlet side, and that catalyst performance depends on the conditions of the portion of the inlet side. The present invention has been accomplished on the basis of these findings.

The present invention has been accomplished on the basis of the findings that deterioration of the honeycomb catalyst occurs in a predetermined range corresponding to a range from the inlet to a site where the flow of the